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ABSTRACT

Uniting two areas of current interest in educational research, a project tested the effectiveness of computer software in observing the process of comprehension monitoring. Passages with embedded comprehension obstacles were presented to two groups of fifth grade students. Identical in content to those of the controls, the experimental subjects' passages flashed comprehension strategies on the computer screen when the subjects reached an obstacle. A follow-up comprehension test revealed no difference in scores between experimental or control groups, indicating that the training did not improve comprehension skills. Reasons for the lack of significant findings might include the high degree of motivation of control, as well as experimental, subjects; the insufficient difficulty of the passages; and the failure of students to grasp the purpose of the experiment. The process data collected during students' reading, however, showed that the experimental subjects used a greater variety of comprehension strategies than did the controls. Further research comparing microcomputer-assisted instruction with traditional classroom instruction is now in progress. (MM)

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COMPREHENSION MONITORING: LONGITUDINAL UNOBTRUSIVE MEASUREMENT WITH MICROCOMPUTERS

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There has been abundant research on the subject of metacognition, a good part of it dealing with comprehension monitoring. Lately, interest in using microcomputers for educational research and instruction has become popular. The purpose of this research was to wed these two areas, comprehension monitoring instruction and research through the use of microcomputers.

Comprehension monitoring "entails keeping track of one's ongoing comprehension success, ensuring the process continues effectively, and taking remedial steps when necessary" (Baker and Brown, 1980, p.1). Many authors agree that comprehension monitoring is critical to good reading (Baker & Anderson, 1982; Brown, 1980; Piaget, 1926; Winograd & Johnston, 1980), and attempts have been made to determine what factors lend themselves to the development of comprehension monitoring skills. Research has shown that age (Brown, 1980; Clay, 1973; Markman, 1977; Pace, 1980), learning disabilities (Katsonis & Paterson, 1980), and cognitive style (Goodenough, 1976; Kagan, Moss, & Sigel, 1963; Spiro & Tirre, 1980) are some factors which influence comprehension monitoring success.

Many research methods have been employed to study comprehension monitoring phenomena. One technique is the interview or self-report procedure (Olshavsky, 1976-77; Smith, 1967; Strang & Rogers, 1965), a second is the recording of spontaneous self-corrections during oral

reading (Clay, 1973; Danks & Fears, 1980). Cloze procedure also has been used to determine reader strategy (DiVesta, Haywood, & Orlando, 1979). Another technique is the error detection method (Baker, 1979; Winograd & Johnston 1980). Baker & Anderson (1982) used computers to study the error detection skills of college students. Several reviews of the comprehension monitoring literature are available which provide indepth treatment of the subject(Anderson, 1982; Brown, Bransford, Ferrara, & Campione, 1982; Kendall & Mason, 1982; Moore, 1982; Pitts, 1983).

Another burgeoning field of study involves the use of microcomputers in education. The proliferation of microcomputers in classrooms, as evidenced by the 96 thousand or more already in use in schools across America (Weiss, 1983), make such research feasible and timely. Johnson (1982a) has succintly outlined the many benefits to be obtained by conducting microcomputer-administered research: 1) sequences of experiments in which one or a few program factors at a time are altered are simple to conduct with microcomputers; 2) observation and recording of responses can be done accurately and unobtrusively; 3) experimenter presence can be eliminated; 4) randomization of subjects to conditions can be left to the computer itself; 5) randomization of experimental material presentation can be handled by the computer; 6) administration time and paperwork can be cut greatly as all data are stored on

diskettes, and multiple copies of the experimental materials can be made quickly from the original. One additional advantage, not mentioned by Johnson, is that children usually are motivated to participate in computer related activities. This is not to say that microcomputer-administered research is without drawbacks. Johnson (1982a) mentions the time and level of training required to construct the computer programs and the problem of machine availabililty. Other potential problems are machine malfunction and data loss through any number of possible occurrences.

Given the many positive reasons for using micros in research, surprisingly little literature exists on experiments conducted in this manner. However, there are two examples which specifically involve reading research: Johnson's (1982b) use of microcomputers to compare the effectiveness of vocabulary acquistion techniques, and Strong's (1981) experiment with programmed reading instruction and motivation. It is also surprising that, while educational software is increasing rapidly, reading programs are usually of a drill and practice nature (Henney, 1982) and have little to do with developing higher level comprehension skills.

Thus, this research project had a three-fold purpose: 1) to develop software for comprehension monitoring instruction purposes; 2) to test the effectiveness of this

software; 3) to observe unobtrusively the process of comprehension monitoring of fifth grade students.

Methodology

Computer Passages

The first step was designing the materials. Using a model proposed by Collins and Smith (1980), six typical obstacles to comprehension at the word and sentence level were embedded in 24 different passages. All passages were six sentences long, and had fourth grade readability level as determined by Fry's Readability Formula (1977), and were either expository or narrative in nature. The obstacles occurred somewhere in the first half of each story. Each lesson consisted of two passages having the same type of obstacle. Experimental subjects' passages were identical to controls' passages in content and order, but they differed in that messages were flashed on the screen when an obstacle occurred, and further flashing messages suggested remedial strategies the reader could employ. For example, after the sentence "The little girl was sitting on a blue quagga" the subjects immediately saw, "Did you see a new word? Read the next line and try to get the meaning." Experimental subjects received these messages throughout lessons one to six. During lessons seven to twelve, flashing messages were seen only for the first passage of each lesson. Passages were programmed so that subjects were able to manipulate text presentation. Pressing the "1" allowed the students to

go on to the next line. A "2" permitted a return to the preceding line. A "3" allowed a review of all previous lines, and a "4" showed all of the remaining text. After each passage had been read students saw five questions related which the students answered in writing on separate answer sheets. The questions were either textually explicit, textually implicit, or scriptally implicit, according to a model developed by Pearson and Johnson (1978). When students had finished answering questions they received feedback in the form of a presentation of possible correct answers on the computer's monitor.

The Real World Reading Test

The next step involved the preparation of the Real World Reading Test (RWRT) from materials typically read by fifth graders. Eleven passages from various grade appropriate textbooks, not in use at the school, were selected on the basis of three criteria: 1) the passage contained at least one of the comprehension obstacles which the experimental students would be trained to recognize and handle, 2) they were typical of materials the students normally encounter in school, and 3) they were either expository or narrative in nature. Because this test was intended to measure the carry-over effects of the training into everyday reading situations, no control of the passages was attempted. Following the passages were a total of 19 textually explicit, 22 textually implicit, and 19

scriptally implicit questions for students to answer in writing. The RWRT was in booklet form, the order of the passages randomized.

Subjects

Subjects were 40 fifth grade students in a private elementary school. All were judged adequate decoders by their teachers. While the school had purchased five microcomputers the previous year, these students had had little in-school exposure to them. The possible effect was to increase student enthusiasm for participation, as all students expressed an interest in computer activity.

Design and Testing

Subjects were randomly assigned to experimental or treatment groups. All subjects were given the Gates-MacGinitie Form D, Level 1 before the training began. Subjects were tested for field-dependence/field-independence, a cognitive style which appears to have predictive validity for comprehension ability, with the Group Embedded Figures Test (Witkin, Oltman, Raskin, & Karp, 1971). The RWRT was administered to half of the controls and half of the experimentals before comprehension monitoring training on the microcomputers began. Following the training period, all students were tested on the Gates-MacGinitie, Form D, Level 2 and on the RWRT. Thus, the experiment involved a Solomon four-group design to remove the external validity threat of

pretest-treatment interaction (Huck, Cormier, & Bounds, 1974).

Both experimental and control group students received training on how to manipulate the presentation of the text before the experimental passages were used. Students attended computer "reading lessons" once a week for an average of 15 minutes per session for a total of 12 sessions. During all microcomputer passage presentations both groups saw a summary of text manipulation instructions at the bottom of the monitor screen.

The students entered each day's session by typing in their names. This opened their files, and each day's data were appended to the appropriate student's file. Recorded by the computer were the text manipulation choice the student made, the line at which the choice was made, how many times a choice was made, and how long a student looked at a line or lines before going on to another part of the text. The subjects, although they were aware of sounds coming from the disk drive, were unaware that information about their reading was being collected by the microcomputer.

Analysis of the Data

Reliability of the Real World Reading Test

Reliability of the RWRT was assessed through calculation of alpha coefficients. The three sub-tests of the RWRT, textually explicit, textually implicit, and scriptally implicit comprehension questions, had coefficients of .61, .74 and .64 , respectively. Total test reliability was .84. Thus, the RWRT was judged reasonably reliable.

Analysis of the Experimental Data

Since the study involved one intervally scaled dependent variable (RWRT test scores), two nominally scaled independent variables (experimental vs. control group and pretest or no pretest with the RWRT measure), and two covariates used to adjust for sampling error in random assignment of the subjects to the four cells in the Solomon four group design (Gates-MacGinitie and GEFT scores), the appropriate statistical analysis to test the study's hypotheses was analysis of covariance. Table 1 presents the results of the analysis.

Table 1
ANCOVA Keyout

Source	Sum of Squares	df	Mean Squares	F
Covariates				
GEFT	.08	1	.08	<1
Gates	900.76	1	900.76	47.9*
Main Effects				
RWRT	74.70	1	74.70	4.0
Group	12.09	1	12.09	<1
Interaction				
RWRT x Gr	36.08	1	36.08	1.9
Error	638.85	34	18.78	
Total	1700.78	39	43.61	

*p < .05

Note: the RWRT pretest effect was significant at p = .054.

Discussion

Of the two covariates, cognitive style, as measured by the GEFT did not have an effect on RWR post-test scores. In view of the field-independence/field-dependence literature which suggests the contrary (Denney, 1974; Egeland, 1975; Spiro & Tirre, 1980; Witkin & Moore, 1974), the finding is unexpected and may be an artifact of the correlation between the covariates. The second covariate, Gates-MacGinitie pre-test, had a significant predictive effect, ignoring groups.

There was no significant main effect for group

membership, that is, there was no difference in post-test scores on the RWRT for experimental versus control groups. However, there was a statistically significant difference (p=.054) in the pre-test versus no pre-test main effect, indicating that having taken or not taken the pre-test influenced post-test scores on the same test. Interaction effects were not significant.

Thus, the results indicate that the training did not produce gains in comprehension skills. Explanations for the lack of significant findings include 1) computer training by itself is not sufficient to improve comprehension monitoring skills, 2) all students, controls and experimentals, were highly motivated and learned something about comprehension monitoring simply through reading the passages and answering the questions, 3) the passages were not hard enough to require use of monitoring strategies, or 4) the students did not get a clear enough idea of what the purpose of the training was.

The experimenters decided to look at the process data unobtrusively collected on the students' reading strategy choices and times spent reading specific lines of passages. This was done in order to determine whether or not the experimental subjects' behaviors were any different from the controls' behaviors following comprehension monitoring instruction. Thus, only the data collected from passages which had no experimental treatment messages for either treatment or controls, e.g., even numbered passages of

lessons 7 through 12, were examined. The rationale was that the best place to examine behavioral or process differences between groups was after training was completed for the experimental group but while they were still encouraged to use the strategies they had been exposed to in previous lessons. The encouragement was in the form of a message, "There will be no flashing messages. Try to use what you learned from those messages while you read the following story." The controls, of course, saw the story with no special messages or instructions.

The researchers were interested in examining whether or not the experimentals used more strategies than did the controls, whether or not experimentals recognized obstacles as evidenced by more time spent on obstacle lines, which strategies were employed by experimentals versus controls, how much time experimentals spent reading versus controls, and whether or not suggestions made in experimental subjects' messages were heeded by them.

The analysis of the process data yielded the following results: 1) experimental subjects spent more time reading than did control subjects; 2) experimental subjects made more strategy choices than did controls; 3) both groups used a line by line strategy most often; 4) both groups used the "line before re-read" strategy about the same amount of the time; 5) experimentals used the "scan ahead" strategy twice as often as did controls; 6) experimentals used the "total

story re-read" strategy about 25% more than did controls; 7) controls spent slightly more time on "obstacle" lines than did experimentals.

Second Phase of the Study

While the results of this preliminary experiment were not statistically significant, they pointed the way for refinements and changes for future research. Particularly encouraging were the findings that training did affect student behaviors in terms of time spent reading and numbers of strategies used. Based on observations, the researchers felt that practice effect and "computer motivation" had influenced the outcome. Therefore, it was decided to conduct a second experiment in which the experimental group would see passages with messages while the control group did regular classroom work and received no comprehension monitoring instruction. This research is now in progress.

Conclusions

The research described here has reaffirmed the experimenters' confidence and enthusiasm for microcomputer-assisted research. Whether or not the microcomputer is a viable tool for comprehension monitoring instruction is yet unknown. The enthusiasm with which the students approached the reading lessons on the microcomputer suggest that this method is motivating to children. However, the many programming variables which contribute to a successful teaching paradigm have not yet been manipulated

systematically; this area represents an important line of research. Some of the variables to consider manipulating are: 1) amount of time on the computer, 2) number of lessons, 3) types of monitoring messages, 4) teacher presentation of material before student-microcomputer work begins, 5) reinforcement of information by the teacher following computer instruction, 6) optimum student age, 7) story format and 8) obstacle difficulty.

Microcomputer assisted research is an exciting new dimension in educational progress, one which deserves use and attention. It will, undoubtedly, greatly increase knowledge about reading in general and about comprehension in particular.

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